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Respectfully submitted,

FROMMER LAWRENCE & HAUG LLP
Attorneys for Applicants

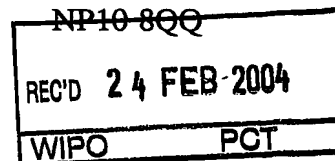
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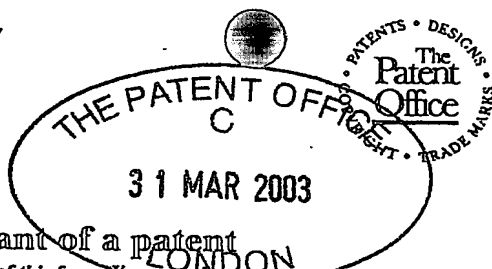
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Patents ADP number (if you know it) If the applicant is a corporate body, give the country/state of its incorporation	UNITED KINGDOM		
4. Title of the invention	VIDEO NETWORK		
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VIDEO NETWORK

The present invention relates to video networks and to video network control arrangements.

5 It is known to link video and audio devices in a studio together using a switching device, typically a cross point switch. The present inventors have identified the need for a system which links audio and video devices in a studio by a switched local area network, for example an Ethernet, operating with a known protocol such as Internet Protocol (IP).

10 The audio and video devices used in a studio may include cameras, editors, audio mixers, and VTRs amongst other examples. Some devices receive and/or produce both audio and video data and some require control data for controlling them. For example VTRs require control data for controlling functions such as play, stop, pause, jog, etc.

According to one aspect of the present invention, there is provided a video network comprising:

15 a plurality of video sources to launch onto the network first, higher resolution, video data and second, lower resolution, video data providing a lower resolution representation of the higher resolution video data;

at least one destination device operable to process video received via network;

a network switch for selectively routing data from the video sources to the destination devices; and

20 a network control arrangement connected to the network switch and having:

- a display device;
- a graphical user interface (GUI) arranged to display, on the display device, the lower resolution representations of video data from the plurality of sources together with identifiers associating the lower resolution representations with the respective sources;
- 25 ◦ means for user selection, by use of the GUI, of a source of video of the first resolution and a corresponding destination device; and
- means for controlling the routing of the higher resolution video data from the selected video source to the selected destination device.

30 Thus, the GUI allows one or more identified sources to be connected to at least one destination and the lower resolution video, which is referred to herein as "proxy" video, provides a means of previewing the video of the sources before one or more of them is selected for connection to at least one destination.

Preferably the display device is arranged to display a plurality of display areas, each display area displaying the lower resolution representation from a respective one of the video sources, together with the associated identifier.

5 Preferably the GUI provides one or more user-operable switches, identified by the identifiers, for selecting a destination device to be connected to a selected video source.

The network control arrangement may comprise a user input device (e.g. a mouse, trackerball, tablet etc) for selecting display screen areas; in which case the user operable switches can be display screen areas selectable by the user input device.

10 To avoid the need for separate user controls, in a preferred the display screen is a touch-sensitive display screen; and the user operable switches are display screen areas selectable by the user touching those display screen areas.

A further alternative arrangement is that the network control arrangement comprises a plurality of user-operable buttons, the buttons corresponding to video sources and/or destination devices for selection.

15 In another alternative arrangement, the GUI provides at least one selection display area and is arranged so that a source is selected for connection to a destination by dragging and dropping a displayed representation corresponding to that video source into the selection display area.

20 Preferably the network is a packet-based network in which the video sources are associated with different respective multicast groups. To allow separate routing of the lower and higher resolution video, it is preferred that each source is associated with at least two respective multicast groups, one multicast group being associated with the higher resolution video from that source and another multicast group being associated with the lower resolution video from that source. Routing can then be conveniently achieved by the
25 network control arrangement sending a message to a destination device to cause the destination device to join the multicast group of the selected source.

Preferably a plurality of destination devices are provided, such as video switching devices, video display devices etc. Examples of video sources are video tape recorders and video cameras.

30 This invention also provides a video network controller for use in a video network having a plurality of video sources to launch onto the network first, higher resolution, video data and second, lower resolution, video data providing a lower resolution representation of the higher resolution video data; at least one destination device operable to process video

received via network; and a network switch, connectable to the network controller, for selectively routing data from the video sources to the destination devices;

the network control arrangement comprising:

- 5 ◦ a graphical user interface (GUI) arranged to display, on a display device, the lower resolution representations of video data from the plurality of sources together with identifiers associating the lower resolution representations with the respective sources;
- means for user selection, by use of the GUI, of a source of video of the first resolution and a corresponding destination device; and
- 10 ◦ means for controlling the routing of the higher resolution video data from the selected video source to the selected destination device.

15 This invention also provides a method of operation of a video network controller in a video network having a plurality of video sources to launch onto the network first, higher resolution, video data and second, lower resolution, video data providing a lower resolution representation of the higher resolution video data; at least one destination device operable to process video received via network; and a network switch, connectable to the network controller, for selectively routing data from the video sources to the destination devices;

the method comprising:

- 20 ◦ displaying, on a display device, the lower resolution representations of video data from the plurality of sources together with identifiers associating the lower resolution representations with the respective sources;
- providing user selection of a source of video of the first resolution and a corresponding destination device; and
- controlling the routing of the higher resolution video data from the selected video source to the selected destination device.

25 Further respective aspects and features of the invention are defined in the appended claims.

Embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a schematic block diagram of a network in a studio;

30 Figure 2 is a schematic simplified diagram of the network showing data flows across the network;

Figure 3A is a schematic diagram of the format of an audio or video packet used in the network;

Figure 3B is a schematic diagram of the format of an AVSCP or CNMCP packet used in the network;

Figure 3C schematically illustrates a unicast data packet;

Figure 4 is a schematic block diagram of a network interface of the network of

5 Figure1;

Figure 5A is a schematic diagram of the format of an data packet used in the network interface;

Figure 5B is a schematic example of current flow assignment;

Figures 5C schematically illustrates data flow in an ENIC;

10 Figures 6A and 6B schematically illustrate a packetiser/depaketiser switch of the network interface;

Figure 7 is a schematic block diagram of an illustrative small network for explaining a mode of operation of the network; and

Figure 8 is a schematic block diagram of a proxy generator of the network interface;

15 Figure 9 is a schematic diagram of one example of the display of a Graphical User Interface (GUI); and

Figure 10 is a schematic diagram of another example of the display of a Graphical User Interface (GUI);

20 Figure 11 is a schematic diagram of an example of a graphical interface for illustrating the configuration of the network:

Figure 12 is a schematic diagram of an example of a graphical interface for illustrating how data is routed across the network;

Figure 13 schematically illustrates a user interface provided on the network manager via which a user may enter configuration data;

25 Figure 14 schematically illustrates a protocol stack; and

Figure 15 schematically illustrates an AVSCP header.

Overview and Terminology

Referring to Figure 1, a network is installed in for example a studio. The network is a
30 multicast network comprising an asynchronous n Gigabit Ethernet switch 2, where n is 1 or 10 for example. Connected to the switch 2 are source "groups" S1 to S10, destination "groups" D1, D2, D3, D8 and D9, and a network control arrangement, in this example a network manager 4 and one or more switching and routing clients 6, 61. In this context, "group" refers to a camera, VTR, DSP etc. which has one or more inputs and/or one or more

outputs. Herein inputs are termed "destination devices" and outputs are termed "source devices" with respect to video. As will become apparent, a destination group may also act as a source and a source group may also act as a destination. An example of a source group is a video tape recorder (VTR) that would have audio, video, status and proxy devices associated with it. The source groups S and destination groups D are coupled to the switch 2 by network interface cards NI 1 to 11 and which are also termed ENICs (Enhanced Network Interface Cards) herein. As indicated with respect to Cameras 1 and 2 and ENICs NI1 and 2, one group may be connected to two ENICs; i.e. one or more inputs and outputs of the group may be connected to one ENIC and the others to the other ENIC.

In a conventional studio, the source groups, e.g. cameras and destination groups e.g. video processors are connected by a cross point switch. The conventional cross point switch requires specific known devices to be connected to corresponding specific known ports on the switch to ensure that they can be connected together via switch. The network of Figure 1 including the switch 2 is configured by the network manager 4 and the switching and routing client 6 to emulate a cross point switch at least to the extent that any one or more sources can be connected to any one or more destinations. For that purpose the network is an IP multicast network using IGMP (Internet Group Management Protocol). Unlike the conventional cross point switch network, the network of Figure 1 connects source devices to destination devices according to identifiers identifying the source devices and destination devices and defining multicast addresses which the identified source devices and destination devices join so that the actual ports of the switch 2 to which they are connected are irrelevant.

It should be noted that this example of the network operates as follows: a single source device belongs to one and only one multicast group to which it transmits data. A destination device receives data from that source device by joining the source device's multicast group. That is done by issuing a multicast group join message. The invention is not limited to that: other ways of operating are possible.

Overview of ENICs

An ENIC is described in more detail in the section below headed ENIC. An ENIC allows any source group, for example a camera, and any destination group, for example a VTR, which is not designed for use with a multicast network to be used in a multicast network. An ENIC is a "dumb" device which can be requested to supply and receive audio, video, and control data streams. An ENIC cannot view or initiate any change to the configuration of the network. An ENIC may subscribe to one or more multicast groups as directed by the network manager 4.

Each ENIC has an Ethernet address and an IP address. A multicast address and a UDP port are used to identify different data streams and in this embodiment a single IP address is associated with each ENIC. However, in alternative embodiments multiple IP addresses could be associated with a single ENIC. It also has an ENIC identifier ID and port
5 Ids for respective ones of the destination devices and source devices of the ENIC. As will be described those addresses and IDs and other data are recorded with the network manager 4. The source devices and destination devices correspond to respective ones of one or more physical inputs and outputs of an ENIC. The source groups and destination groups may have "tally text" associated with them. An example of tally text is a name such as "VTR1" which
10 may be given to a VTR or a cameraman's name e.g. Jim which may be given to a camera. The tally text is recorded at the network manager. All groups connected to the network may be named in this way. Source devices may have tally text, termed sub_tally herein, associated with them.

An ENIC acts as a switch which switches data received from the switch 2 to a
15 specified physical output of the ENIC and switches data from a specified physical input to the switch 2.

The network, implemented using the switch 2, is asynchronous, but video and audio needs synchronous processing. The video and audio devices connected to the network operate on serial digital data, for example SDI. The ENICs convert serial digital video and
20 audio to multicast UDP/IP packets and convert multicast UDP/IP video and audio packets to serial digital video and audio. The ENICs also provide synchronous operation over the network and, as will be described, align frames of different video streams for purposes such as editing. The ENICs also generate low resolution video streams referred to herein as "proxy video" as will be described.

25 The network optionally also comprises a master ENIC NIM which will be described in more detail in the section Frame Start Alignment below.

Overview of Network Manager

The network manager 4 which may comprise a computer, for example a Personal Computer (PC), is linked to the network via a standard network interface card. There may be
30 only one network manager connected to the network. The network manager maintains a database of the configuration of the network. It allocates resources to the client(s) 6 and ENICs NI, sends commands that change AV connections across the network and ensures the switching and routing client's view of the network is correct. The network manager, amongst other functions, defines respective multicast groups to which the source devices belong. In

alternative embodiments a further network manager may be provided such that there is a master network manager and a slave network manager, which would provide a safeguard against failure of one of the network managers.

5 The manager records, in relation to each ENIC, the Ethernet address the IP address of the ENIC and a reference that is used as a reference in the network manager. The IDs of the source and destination devices of an ENIC are recorded at the network manager 4. The source groups and destination groups and may have "tally text" associated with them. An example of tally text is a name such as "VTR1" which may be given to a VTR or a cameraman's name e.g. Jim which may be given to a camera. The tally text is recorded at the
10 network manager. In addition, a source device may have sub_tally text which is recorded at the manager 4. Other data is also recorded as described in the next section Network Configuration Data.

Network Configuration Data

15 The network manager stores and maintains a set of data relating to each of a number of different categories of device on the network.

In particular, the network configuration data is of four basic types relating to 4 different types of device.

- 20 1.SOURCE device: Video, Audio and Status is prepared by an ENIC and transmitted to a multicast group on the network. Each SOURCE device can also transmit a proxy.
- 2.DESTINATION device: Video, Audio and Status is received from the network by joining a multicast group.
- 3.CONTROL_SOURCE device: Control commands are generated by an ENIC or
25 Client and are transmitted unicast to a CONTROL_DESTINATION.
- 4.CONTROL_DESTINATION device: Receives control commands unicast from a CONTROL_SOURCE.

30 The client 6 cannot directly access the SOURCE and CONTROL_DESTINATION devices. These devices are members of a CONTROL_SOURCE_GROUP, a structure that groups devices that cannot be controlled independently. For example, SDI outputs from a VTR are connected to an ENIC for transmission onto the network 2. The SDI input is represented as two SOURCE devices (V_o , A_o) in the network configuration. All of these devices are from the same physical device, are jointly controlled and have a common time

code and stream status, i.e. stop, FF(fast forward), rew (rewind), etc.

A predetermined set of information is stored in relation to each of the above device types, for example a device identifier, a destination IP address associated with the device and a UDP port and/or IP address of an ENIC associated with the device.

5 A predetermined set of information associated with an ENIC known as an ENIC structure is held in a database in the network manager and comprises the Ethernet address and IP address of the ENIC. The ENIC structure also maps the associated devices (e.g. audio and video streams) to the physical ports on the card and includes any hardware limitations that restrict the ideal model described above. When an ENIC starts up it will
10 receive information on what devices are connected to its RS422 ports (i.e. VTR, TALLY), so that the correct driver can be used.

Overview of Switching and Routing Client 6.

15 There may be one or more clients 6, 61 connected to the network but the following description assumes there is only one. The network manager 4 provides the client 6 with information specifying the configuration of the network. The client 6 can initiate a connection between a source device and a destination device across the network. All requests for initiating such changes to the configuration of the network are sent to the network manager 4. Control data which does not change the configuration of the network may be
20 issued by the client 6 directly to an ENIC and, via ENIC, a group associated with the ENIC. For example control data causing the video switcher D8 to switch may be sent directly from the client 6 to the switcher D8 via ENIC NI8.

25 The switching and routing client 6 which may be a computer, for example a PC, is linked to the network via a standard network interface card. The client 6 in this example controls the ENIC NI8 and/or the video switch D8 and controls the supply of video to the ENIC NI8. It also controls supply of video and audio to other destinations, e.g. D2 and D3 via ENICs NI9 and NI10. The control of the ENIC NI8 by the switching and routing client 6 takes place via network manager 4. The further switching and routing client 61, if provided,
30 would control another destination device. The following description assumes that the network comprises only one switching and routing client 6.

Protocols and Data flows, Figure 2

The network is an Ethernet network on which various conventional protocols including UDP/IP, TCP/IP, and IGMP (Internet Group Management Protocol) are run. Other protocols are also used as will be described below.

Referring to Figure 2, Figure 2 is a simplified diagram of the network of Figure 1 showing only the Network manager 4, the client 6, and some of the ENICs: NI1, NI2 and NI8 by way of example.

AVSCP

The network manager 4 communicates with the ENICs using a protocol AVSCP (Audio Video Switching Control Protocol), which is proprietary to Sony Corporation. AVSCP uses UDP (*User Datagram Protocol*) to carry its messages. UDP is a connectionless transport protocol, which means that a one-way data packet is sent by the sending device without notifying the receiving device that the data is en route. On receipt of each data packet, the receiving device does not return status information to the sending device. The data format is described in the section Data Format and Figure 3B below.

AVSCP is a proprietary protocol used to determine the routing of audio, video and control data. AVSCP is used for communication between the network manager and each ENIC for the purpose of connection control and in order to monitor the operation status of ENIC and AV ports. For example if it is desired to connect a video tape recorder (VTR) destination to a camera source to receive AV data then the switching control server 6 (see Figure 1) must send an instruction to the ENIC port associated with the destination device, in this case the VTR, to join the specific multicast group that is sourced from the camera. This instruction between the ENIC and the switching control server 6 is sent via the AVSCP protocol.

AVSCP has five main functions which are to:

- 1) Monitor the operational status of the ENICs;
- 2) Discover the configuration of an ENIC;
- 3) Stop and start audio and video source transmission;
- 4) Direct ENICs and their associated audio and video devices to join multicast groups; and
- 5) Set up and tear down paths for conveying control data across the network.

The network manager 4 should be aware of the operational status of an ENIC before it can send any instructions to it. Accordingly the AVSCP requires an ENIC to send status messages to the server periodically. The network manager 4 can only control AV stream transmission and reception of an ENIC when it is operational. The network manager 4 can alternatively obtain the current configuration of an ENIC by sending a configuration

request message to it. The ENIC responds by returning a message specifying the current configuration.

Figure 14 schematically illustrates how AVSCP relates to other functional modules in an ENIC network protocol stack. The arrangement of Figure 14 shows identical protocol stacks of two different ENICs 1100A and 1100B and a protocol stack of the network manager 1120. The ENIC protocol stack comprises an AVSCP layer 1104 that sits on top of a UDP/IP/Ethernet layer 1102. Other protocols 1106 may also be implemented at the same level of the protocol stack as AVSCP. The AVSCP layer communicates with a higher layer comprising ENIC applications via an AVSC_request command and an AVSC_indicate command. An uppermost layer of the ENIC protocol stack 1100A represents a local configuration 1110 of the network. The network manager protocol stack 1120 is similar to the ENIC protocol stack 1100A in that it comprises an AVSCP layer 1124 that sits on top of a UDP/IP/Ethernet layer 1122. However, a server applications layer 1128 sits on top of the AVSCP layer 1124 and communications between these two layers are mediated by the AVSC_request command and the AVSC_indicate command. The server applications layer 1128 is in communication with a higher layer corresponding to a network configuration database 1130. The AVSCP protocol layer of the ENIC 1104 may send AVSCP protocol messages to the corresponding AVSCP protocol layer 1124 of the network manager.

The AVSCP_request is a primitive command that is sent from the application layer 1108, 1128 to the AVSCP protocol layer 1104, 1124. An application initiates an AVSCP_request in order to send an AVSCP message to another AVSCP entity. The AVSCP request has the following parameters: IP address of the message destination (typically an ENIC); AVSCP message type (e.g. STOP_TX, SWITCH etc.); and number of information elements required by the message.

One or more remote client controller devices (not shown) may access the server applications layer of the network manager 1120 via a client controller interface (not shown). The client controller interface of the network manager 1120 enables a client controller to connect remotely with and exercise a subset of control functions over a subset of ENIC devices.

Figure 15 schematically illustrates the structure of an AVSCP header. The AVSCP header has a fixed length of 32 bits. The first octet (bits 0 to 7) is used as a protocol identifier. It has a value of 0xCC. The purpose of a protocol ID is to detect possible collision with other protocols if they happen to use the same port number. The second octet (bits 8 to 15) is used as version number for the protocol. The third octet (bits 16 to 23) is reserved for

future use. The fourth octet (bits 24 to 31) indicates the message type. The last 4 octets of the AVSCP header is a session-ID, which is a random number chosen by the command message initiator to tie up acknowledgement message returned by the responder to the original command message.

5

CNMCP

The network manager 4 and the switching and routing client 6 communicate with each other using CNMCP (Client Network Manager Communication Protocol) the messages of which are carried by TCP (See Section Data Format and Figure 3B below for a description of the data format). CNMCP is also a protocol that is proprietary to Sony Corporation. TCP is a connection-oriented protocol, which means that before any data is transferred between network nodes, the sending and receiving devices must co-operate in the establishment of a bi-directional communication channel. Subsequently, each package of data sent across the local network receives an acknowledgement and the sending device records status information to ensure that each data package is received without errors.

CNMCP is a protocol that is used for communication between the network manager and the clients. CNMCP enables control messages such as registration request, a switch request or a permissions update from client to network manager and further enables control messages such as a registration response, a switch response, an update indication (specifying device configurations) and a permission response from network manager to client. By sending CNMCP messages to the client, the network manager 4 informs the client 6 of data associated with the ENICs which are connected to the network and data associated with source devices and destination devices connected to the network by the ENICs. By sending CNMCP messages to the client, the network manager 4 informs the client of the multicast IP addresses on which it can receive the proxy video streams, audio streams and status streams. The network manager can determine whether sufficient bandwidth is available to service a client request and mediates access to network resources accordingly. However, it is also possible for the client to join a multicast group directly without requesting access via network manager. This may be appropriate where, for example, the client requires only a low data-rate connection.

Alternatively to CNMCP, a known protocol such as Simple Network Management Protocol (SNMP) may be used. The client 6 can cause the network to connect Audio and Video streams from source devices specified by the client to destination devices specified by

the client and to specify control data routing by sending CNMCP or SNMP messages to the network manager.

Audio and Video Data (RTP)

5 For sending streams of audio and video data from the sources to the destinations, the transport layer is UDP multicast. The audio and video data are carried in Real-Time Protocol (RTP) format within a UDP packet. This applies to the audio data, the full resolution video and the low resolution proxy video. (See Section Data Format and Figure 3A below for a description of the data format). RTP provides functions to support real-time traffic, that is, traffic that requires time-sensitive reproduction at the destination application. The services provided by RTP include payload type identification (e.g. video traffic), sequence numbering, time-stamping and delivery monitoring. RTP supports data transfer to multiple destinations via multicast distribution if provided by the underlying network. The RTP sequence numbers allow the receiver to reconstruct the original packet sequence. The sequence numbers may also be used to determine the proper location of a packet. RTP does not provide any mechanism to ensure timely delivery, nor does it provide other Quality of Service guarantees.

When an ENIC receives an AVSCP switch request from the network manager 4, the ENIC sends an IGMP join message to the switch 2 to join the multicast group of the data it needs to receive.

Unicast Control Data (UCD)

Control data may be sent, only as a unicast, directly from one ENIC to another. That allows, for example, a controller connected to one ENIC to control a device connected to another ENIC. For example, commands such as play, pause stop, record, jog etc. may be sent from a controller across the network to a group such as a VTR. Such control data may also be sent from the client 6 and/or the network manager 4 to a control a device. The control channels are set up using AVSCP- see ANNEX 1. The control data itself is carried in UDP in this embodiment. However, TCP may alternatively be used to carry control data.

Stream Status (SS)

30 A controller connected to the network at one ENIC and controlling a group connected to a second ENIC needs to know the status of the controlled group. Status data may be sent from the controlled group to the controller via network. Also the client 6 may wish to receive the status data. Since status data is likely to be low-bandwidth, CNMCP is

used to enable the client to receive the status information without the intervention of the network manager.

Data Formats- Figures 3A, 3B, 3C.

5 Audio and Video Data

Referring to Figure 3A, the audio and video data format comprises, in order, an Ethernet header, an IP multicast header, a UDP header, an RTP header, a field specifying the type of payload, the payload, and a CRC field. The Ethernet header comprises a source Ethernet address and a destination multicast Ethernet address. The IP multicast header
10 comprises the source ENIC IP address and the destination multicast IP address. There are several different IP address classes e.g. Class A has the first 8-bits allocated to the network ID and the remaining 24-bits to the host ID whereas Class B has the first 16 bits allocated to the network ID and the remaining 16-bits to the host ID. Class D IP addresses are used for multicasting. The four leftmost bits of a Class D network address always start with the
15 binary pattern 1110, corresponding to decimal numbers 224 through 239, and the remaining 28 bits are allocated to a multicast group ID. The Internet Group Management Protocol (IGMP) is an Internet layer protocol used in conjunction with multicasting and Class D IP addresses.

The set of hosts (i.e. source and/or destination devices) listening to a particular IP
20 multicast address is called a host group. A host group may span multiple networks and membership of a host group is dynamic. The Class D IP address is mapped to the Ethernet address such that the low-order 23 bits (of 28) of the multicast group ID are copied to the low-order 23 bits of the Ethernet address. Accordingly 5 bits of the multicast group ID are not used to form the Ethernet address. As a consequence the mapping between the IP
25 multicast address and the Ethernet address is non-unique i.e. 32 different multicast group IDs map to the same Ethernet address.

The UDP header comprises source and destination port numbers, which are typically associated with a particular application on a destination device. Note that UDP is redundant in the case of multicast messages since in this case the multicast group address identifies the
30 stream/content. The audio/video streams are transported using RTP protocol. Forward Error Correction (FEC) may be used for certain data streams e.g. full resolution video streams to provide a level of protection against data corruption due to network errors. FEC is provided using a known RTP payload format that provides for FEC. FEC is a parity-based error protection scheme. A known extension to the RTP protocol allows a video scan line number

to be specified in the RTP payload header. The RTP header also comprises a field to specify whether 8-bit or 10-bit video is present. Although known RTP and RTP/FEC protocol formats provide the data packet fields necessary to transport audio and video data over an IP network it may also be desired to transmit additional information such as source status and source timecode information. For example if the source is a VTR then the timecode as stored on the tape should be transferred across the network. The source status information might indicate, for example, whether the VTR is currently playing, stopped or in jog/shuttle mode. This status information allows a user to operate the VTR from a remote network location. Since the timecode data and source status information is required only once per field, the information is transported in an RTP packet marked as vertical blanking. To allow audio and video resynchronisation, the RTP timecode is based on a 27MHz clock. The payload type field contains data indicating the type of payload. i.e. video or audio. The payload field contains the video or audio data. The CRC is a cyclic redundancy check known in the art.

15 AVSCP and CNMCP

AVSCP and CNMCP messages are carried by a data format as shown in Figure 3B. The format comprises in order, an Ethernet header, an IP header (which is not a multicast header), a UDP or TCP header, the payload, and a CRC field. The Ethernet header comprises source and destination Ethernet addresses. The IP header comprises the source ENIC IP address and the destination ENIC IP address. UDP is used for AVSCP and TCP is used for CNMCP. The payload field contains the AVSCP or CNMCP message. The CRC is a cyclic redundancy check known in the art.

Stream Status Format

25 The stream status format is identical to the audio and video data format as shown in Figure 3A, with the exception of the content of the payload section. The frame comprises an Ethernet header, an IP multicast header, a UDP header an RTP header, a payload type identifier a stream status data payload and a CRC field.

30 Unicast Control Data Format

The unicast control data format is shown in Figure 3D and comprises an Ethernet header, a standard IP header (not multicast), a UDP header, a payload section assigned to unicast control data and a CRC field. IGMP is a known protocol. Multicasting that extends beyond a single network is complicated by the fact that Internet routers must establish

whether any hosts on a given physical network belong to a given multicast group. IGMP is typically used to establish this information. IGMP lets all nodes of a physical network know the current association of hosts to multicast groups. IGMP messages are transmitted in IP datagrams and have a fixed 8-byte IGMP message size concatenated with a 20 byte IP header. The IGMP message includes a 32-bit Class D IP address.

A number of IGMP queries and reports are used by multicast routers (e.g. the switch 2 of Figure 1) to record which network interfaces have at least one host (device or group) associated with a multicast group. When the router receives a multicast message to forward, it forwards the message only to interfaces that currently have hosts associated with that multicast group.

ENIC, Figure 4

An ENIC joins a multicast group by sending an IGMP join message to the asynchronous switch 2. An ENIC may send and/or receive data in all of the formats shown in Figures 3A, 3B and 3C. It will be noted that an ENIC does not send or receive CNMCP data.

Referring to Figure 4, an ENIC comprises a network processor 20, a buffer and packet switch 22, a packetiser/depaketiser 24, a control processor CPU 26, a peripheral component interconnect (i.e. computer interface) PCI 28, a clock 202, a clock synchronisation circuit 204 and a frame synchronisation circuit 205. The clock synchronisation circuit 204 is described in co-pending UK patent Application 0204242.2. The frame synchronisation circuit is described in co-pending patent application _____ (Agent reference P015702GB)

The packetiser/depaketiser has 3 video inputs 218 for receiving respective SDI video streams, 3 audio inputs 220 for receiving respective audio streams. Alternatively, three input ports could be provided for receiving combined SDI audio/video streams and the audio and video streams could be subsequently separated to form 3 audio and 3 video streams with in the ENIC. The packetiser/depaketiser 24 has likewise 3 video outputs 222 and 3 audio outputs 224.

The CPU 26 has 3 control data inputs 226 and 3 control data outputs 228.

The three video inputs 218 are connected to respective ones of three substantially real-time proxy video generators 212 which generate the low resolution versions of the video streams as will be described below. The outputs of the proxy generators and the inputs 218 are connected to a packetiser and multiplexer 214, which converts the full resolution serial video from the inputs 218 and the proxy video from the proxy generators 212 to packets. The

packets are supplied to the packet switch 22. The packetiser/depaketiser 24 has a depaketiser 216 and demultiplexer for receiving packets representing the video and audio channels from the packet switch 22. It depaketises and demultiplexes the video and audio into 3 serial video streams and 3 serial audio streams for supply to respective ones of 3 video outputs 222 and 3 serial audio streams for supply to respective ones of 3 video
5 outputs 222 and 3 audio outputs 224. Thus the packetiser/depaketiser 24 provides routing of the video and audio received from the packet switch 22 to outputs 222 and 224 and routing of the video and audio received from the inputs 218 220 to the switch 22. The packetiser/depaketiser 24 also provides synchronisation of the different video and audio streams in conjunction with the clock synchronisation circuit 204 and frame alignment of the
10 video frames of the different video streams in conjunction with the frame synchronisation circuit 205.

The packet switch 22 provides routing of video, audio and control packets received from the network processor 20 in accordance with tags applied to the packets in the network processor 20. The network processor 20 generates the tags in accordance with header data in
15 the received packets. There are two sorts of tag: a "flow" tag which defines the route through the packet switch 22 and a "type" tag which defines the final output to which the packets are supplied by the packetiser/depaketiser 24. The video and audio packets are routed to the depaketiser 216 and the control packets are routed to the CPU 26. The CPU provides 3 control data channels 228 here denoted "RS422" because they provide control similar to that
20 provided by RS422 in a conventional studio. CPU 26 also receives 3 control data channels 226.

The network processor 20 comprises UDP/IP filters 208, which detect sync, audio, video, status and control data packets received from the network using the headers of those packets. Clock sync packets are directed by the network processor 20 directly to the clock
25 synchronisation circuit 204 to synchronise the clock 202 with a master reference clock as described in the co-pending UK patent application 0204242.2. Frame sync packets are directed by the network processor to the frame sync circuit 205. The network processor directs the sync packets directly to the clock synchronisation circuit 204 frame synchronisation circuit 205 to reduce time delays which would reduce the accuracy of the
30 synchronisation. Other packets, for example AVSCP, which are not recognised by the filters 208 are directed to the CPU 26 although filters could be set up for these.

Tags are attached to the audio and video packets in accordance with the header data received with them. The tagged video and audio packets are supplied to the packet switch 22 which routes them to the depaketiser 216 or PCI 28. The tagged control data packets are

directed by the packet switch to the CPU 26. The packet switch 22 is described in more detail below.

Routing Data in an ENIC

1. Data received from the network

5 An ENIC may receive from the network 2: audio and video data as shown in Figure 3A; AVSCP data as shown in Figure 3B; stream status data (which is in essentially the same format as shown in Figure 3A); and unicast control data as shown in Figure 3D. The Ethernet header provides the physical address of the ENIC allowing a packet to be delivered by the network 2 in known manner to the ENIC.

10 The network processor 20 of the ENIC (see Figure 4) has the UDP/IP filters 208 that extract the IP and UDP headers, decode the address information in the headers, detect the payload data type from the payload type field (see Figure 3A). The network processor 20 then replaces the packet header with a tag identifier, which specifies a data processing route through the ENIC for the corresponding data to a target data handling node such as a video or audio processor. Figure 5A schematically illustrates the data format of a tagged packet.

15 The tagged data packet is 32 bits wide and is of indefinite length i.e. the payload has a variable length. The first 32 bits of the tagged packet comprise an 8 bits "flow" data field, an 8-bit "type" data field and a 16-bit "size" field. The next 32 bits are currently unused. The unused field is followed by a payload field. For audio and video data the tagged packet

20 payload comprises the RTP header and the payload type data in addition to the audio or video data payload of Figure 3A. In the case of AVSCP/CNMCP data packets and unicast control data packets (see Figures 3B and 3C) the tagged packet payload is the message data.

 The flow data field defines the output of the packet switch 22 (Figure 4) corresponding to the target data-handling node for which the tagged packet payload is

25 destined. The type data field determines what the target processor does with the data and the size data field specifies the payload size.

 Figure 5B schematically illustrates an example of a flow assignment allocation. In this example flow 0 corresponds to data that will not be passed to any target processing device e.g. untagged data; flows 1 and 4 correspond to video input and output ports 218, 222

30 (see Figure 4); flows 2 and 5 correspond to CPU data flows from and to the network; and flows 3 and 6 correspond to PCI data flow from and to the network.

 Figure 5C schematically illustrates how video data, PCI data, network data and CPU data is mapped to each of the six defined flow paths via multiplexers (MUX) and demultiplexers (DEMUX). Each of the data flows of Figure 5B is associated with a FIFO.

There is no direct means of determining the size or number of packets written to the FIFO since this is not necessary. The tags associated with the packets specify the packet size so only a "not empty" indication for the FIFO is required by a MUX to perform a read operation. The MUX modules are programmable (by external means such as a CPU) such that they are sensitive only to particular flows. This enables virtual flow paths to be set up across the buffer and packet switch 22 of Figure 4. Similarly, to avoid contention, only a single DEMUX module can write into any one data flow. Again, the mapping is programmably controlled by external means.

Referring to Figure 6A, the video section of the packetiser/depacketiser 24 is shown. It comprises a demultiplexer 2401 which responds to the "type" data in the tags attached to the video packets to feed video packets to three channels V0, V1 and V2 denoted by the type data. Each channel comprises an RTP/FEC decoder 2402, 2403, 2404 followed by a frame store 2405. The RTP decoder 2402 removes the tag from the packet it receives and writes the packet into the frame store at the address defined by the RTP packet header, in particular the line number data thereof, to create a video frame having the video data in the correct order.

Example of operation 1

In this example, two video streams are sent to an ENIC for example NI8 in Figure 1 and provided by that ENIC to the video switcher D8 which switches from one stream to the other.

The ENIC receives from the network 2, video packets from two video source devices for example video outputs of camera 1 S1 and camera 2 S2. To receive those packets the ENIC NI8 is ordered by an AVSCP message from the network controller 4 to join the multicast groups of the two video source devices of groups S1 and S2. The AVSCP message is detected by the network processor 20 and fed to the CPU 26 which issues a IGMP join message to the network. The video packets are received by the network processor 20. The destination IP address for the video packets, specified by the IP header corresponds to the multicast group that defines the data stream and thus determines to which subset of destinations on the network the data stream is routed. The headers are removed by the network processor and replaced by the tags. The packet switch 22 routes the video packets to the demultiplexer 2401 according to the flow data in the tag. The demultiplexer routes the packets to channels 2402 and 2403 (by way of example) in which the video frames are reconstructed from the packets in frame stores 2405 and 2406. In addition, the frame sync

circuit 205 of Figure 1 aligns the frames of the two video streams. The video switch D8 receives the two video streams from the ENIC. The video switch also receives control data from the CPU 26 of the ENIC NI8. The control data is sent by the switching and routing client 6 as unicast control data which is received by the network processor 20. The unicast control data has a header that identifies it as a control packet and these control packets are routed to a CPU on the ENIC. The control data orders the video switcher D8 to switch its output from one of the video streams to the other.

Example of operation 2.

In this example two video streams are sent to an ENIC, for example ENIC NI8 in Figure 1, and that ENIC switches an output from one stream to the other. A small network is shown in FIGURE 7 that consists of two cameras ('Camera 1' and 'Camera 2'), a DME unit, an AB switch and a monitor with tally that shows the output of the system. The broken lines represent a network connection and the unbroken lines an SDI connection to an ENIC.

Sources are categorised as either linked sources or pure sources. A linked source is a source that has been supplied to the network by a destination device, for example a data processor (e.g. chroma keyer) that receives data via the network and subsequently outputs processed data onto the network as a source for another network device. For such linked sources, the meaning of the data (i.e. what the data conveys) is not changed by the processing operation. A pure source is a source that supplies to the network for the first time.

The video source device for each camera is a 'pure' source. Each camera has a user group called "Producer" and the Producer has set the tally tag to be the name of the cameraman, i.e. FRED or JIM. There are three other ENICs on the network. The first performs a visual effect on the video from 'Camera 1' and is called ENIC_DME since it performs digital multi-effects (DME). This ENIC will have two device entries in the database, called 'DME In' and 'DME Out'. 'DME In' is a destination device, which has a video link to 'DME Out'. 'DME Out' is a source device, which has a video link to 'DME In' and transmits onto the network. 'DME Out' also has a tally entry of E1 (indicating EFFECT 1). The second ENIC performs a seamless switch between two sources and is called ENIC_AB_SWITCH. This ENIC will have three device entries in the database, called 'Switch A In', 'Switch B In' and 'Switch Out'. 'Switch Out' is a source device that will either be linked to 'Switch A In' or 'Switch B In', depending on which video source is selected. The third ENIC is called ENIC_AIR and has one device called 'Monitor' (a monitor with a tally). 'Monitor' is a 'pure' destination device (LINKED = 0) that receives

video from the AB switch. It also has a tally that displays the METADATA from its source device, 'Switch Out'.

Say that the AB switch is showing channel A and the METADATA of Camera 1 changes. Maybe ROB replaces FRED. A request will be sent to the Network Manager to
5 changed FRED to ROB. The Network Manager will examine each destination Device that is subscribed to Camera 1's multicast group and update the view of any client that is displaying it. If any of these destination devices is a linked device, then it must navigate to the corresponding linked source device and update all of its destinations, and so on. In the scenario above, 'DME In' is the only destination device and it is linked to 'DME Out'.
10 'DME Out's' METADATA (EI) is concatenated to ROB to form ROB_EI and all of its destinations must be notified. The only destination device is 'Switch A In'. Since the switch is showing channel A, 'Switch A In' is a linked destination device and we must update all destinations of its corresponding source device ('Switch Out'). 'Switch Out' only has one destination and this is a pure destination 'Monitor'. The tally of 'Monitor' is updated with
15 'ROB_EI'. Another scenario is when we perform an AB switch. A request will be sent to the Network Manager to perform a seamless AB switch between devices 'Switch A In' and 'Switch B In'. If the network has been configured correctly, as above, then this is allowed. Since SRC_DEVICE of 'Switch B In' references 'Camera 2', we can navigate to 'Camera 2' and update its status as being *ON AIR*. Similarly, we can take 'Camera 1' *OFF AIR* by
20 navigating back through the devices from 'Switch A In'. The correct tally, i.e. JIM can now be propagated to 'Monitor' as already described.

2. Sending data to the network Figures 6B and 6C.

Referring to Figure 6B, one channel of SDI video is received by a buffer 2408 from
25 an SDI source such as a camera. The buffer 2408 stores the video temporarily whilst it is packetised by an RTP/FEC encoder 2410 and sent to a buffer 2412 for temporary storage. A tag generator 241 adds to the RTP packets a tag comprising flow and type data as shown in Figure 5. A multiplexer 2416 receives the tagged packets from the tag generator and multiplexes the video packet with other video packets from similar video channels. The tag
30 is defined by data produced by the CPU 26 in response to an AVSCP message received from the network controller 4. As shown schematically in Figure 5B, the packet switch directs the video packets to the network processor (net) or to the PCI 28 according to the flow data in the tag. Audio packets are similarly processed and routed.

Where packets are to be routed to the network, a header generator 210 strips the tag from the packet and, based on the flow and type flags, generates an appropriate part of the network header which is appended to the packet.

5 Proxy Video

Referring to Figure 8, proxy video is generated from SDI video as follows. A horizontal filter 70 applies a low-pass FIR filter to the SDI input data. Output of the horizontal filter is supplied as input to a horizontal subsampler 71, which subsamples the SDI video horizontally to reduce the horizontal resolution. A vertical subsampler 72 reduces the vertical resolution of data received from the horizontal subsampler 71. The resulting proxy video is then encoded by an encoder 74 to form RTP packets. There is one proxy video generator for each video channel. The proxy video is processed in the same way as the SDI video by the packetiser 24, the packet switch 22 and the network processor 20. The proxy video is always directed to the switching and routing client 6, or one of the switching and routing clients 6 and 61. Thus one proxy video stream is multicast in a first multicast group to which the client 6 and/or 61 joins and the SDI video from which that proxy video is derived is multicast in a second multicast group. The multicast group is defined by the class D IP address that identifies the data stream. In an alternative embodiment alternate fields of either the proxy video stream or the higher-resolution SDI video stream could be assigned to different multicast groups.

In a currently preferred example of the invention, the proxy video comprises 180 samples \times 144 lines (PAL) or 180 samples \times 120 lines (NTSC) and 25 or 30 frames per second, with horizontal and vertical filtering. The number of bits per sample may be 24 bits (i.e. 3 colours, each 8 bits) or 16 bits (i.e. 3 colours, each 5 bits).

25 Switching and routing client 6

Referring to Figures 9 and 10, examples of graphical user interfaces (GUI) are shown. In this example of the invention, the GUI is provided by the switching and routing client 6. However the GUI may be provided by the network manager 4 or by both the network manager 4 and the switching and routing client 6. The GUI is an interface with underlying software which reacts to actions taken by the user using the GUI.

30 Data flows

The GUI displays information about the configuration of the network provided to it by the network manager 4. That information is provided using the CNMCP protocol as

discussed above. The GUI also displays proxy video provided by the ENICs using the Real Time Transport protocol described above. The proxy video is multicast and to receive it the switching and routing client joins the multicast groups of the proxy video streams. The routing of data is established using IGMP message commands. The GUI may be used to initiate control of a controllable group such as a VTR. The switching and routing client unicasts control data directly to the ENIC associated with the controlled group in response to an action taken via GUI. Unicast control data is described above. The switching and routing client receives status stream data which is multicast as described above and the client joins the multicast group thereof.

When the GUI is used to initiate a routing of video from a source device to a destination device, it sends an CNMCP message to the network manager 4. The network manager sends an AVSCP message to the ENIC associated with the destination device to cause it to join the destination device to the required multicast group.

The client 6 is able to send IGMP join messages to the network. However, the client may also self-subscribe to a multicast group for communication of status, audio and proxy data streams only. The network manager controls client access to a multicast group corresponding to a video stream. The GUI

The following description assumes that the GUI is operated in conventional manner using at least a pointing device such as a mouse and/or a keyboard. Alternatively, a keyboard interface having "hot keys" mapped to particular GUI commands or a touchscreen interface may be used to issue commands. The GUI of Figure 9 has three main display areas A1, A2, and A3.

Area A1 is a network management area displaying graphical representations of the groups (e.g. Cameras CAM1 etc and VTRs VTR1 etc) and their source devices (e.g. output CAM V1 of CAM1). The graphical representations of the groups are displayed with the tally text (e.g. CAM 1) and the source devices with their sub-tally text (e.g. CAM V1). The data for creating the display in the area A1 is derived from the database held by the network manager and provided to the switching and routing client using CNMCP messages.

Area A2 is a source content review area which has plurality of proxy video display areas or windows W1 to W10. In this example there are 10 such windows but there can be any convenient number thereof. The windows W1 to W10 display proxy video. In this example the proxy video to be displayed in the windows is chosen by dragging a source device from the network management area A1 to a window. That causes the underlying software to send an IGMP join message to the network to join the required multicast group

The windows have respective label areas L1 to L10 in which the GUI displays the appropriate tally text and/or sub tally text.

Area A3 is a routing review area comprising buttons B which act as switches. There are two rows of buttons in this example: a row of buttons associated with groups and/or source devices and labelled with the appropriate tally text and a row of destination buttons also labelled with tally text. By operating a source button and one or more destination buttons the source indicated by the button is linked across the network to the selected destinations. In the example of Figure 9, the highlighted buttons show CAM 1 is linked to MON1, VTR 2, and DSP2. Audio associated with CAM1 is linked to AU OUT 3.

By way of further explanation, assume a source CAM1 is to be connected to MON1. When a Network Client starts up, it connects to the Network Manager on a known port and the Network Manager sends information on the source devices, which are available to it. This allows the client to form a view of the network. Each device is delivered to the client with an ID, which the client will use to describe the device in subsequent communication with the Network Manager. A destination device may be a Monitor for example. If the client wishes to route video from a source group (e.g. a VTR) then it will send to the Network Manager a CNMCP Switch message that contains the IDs of the destination device and of the source device.

If the client is not permitted to perform this operation then the Network Manager will send a CNMCP NAK message to the client in response. Otherwise it will process the request as follows.

The Network Manager will examine the database and determine which multicast IP address the video is being transmitted to. An AVSCP Switch message will be created that contains this IP address and it is sent to the ENIC, which connects the Monitor. The ENIC embedded software sends an IGMP Join message to this IP address and sends an AVSCP ACK message back to the Network Manager. The ENIC should now be receiving the desired video data and will send it to the SDI output that connects the Monitor. Meanwhile, the Network Manager, having received the AVSCP ACK message, will update the routing information in the database. The Network Manager sends a CNMCP ACK message back to the client to indicate success.

The GUI of Figure 9 preferably also includes, as shown, two further display areas M1 and M2 showing the video displayed on play-out monitors MON 1 and MON2. In this example MON2 has a dark border indicating that it shows the video being played out on LINE OUT 1 from for example VTR1. MON 1 which has a lighter border shows the video

from CAM1 which has been preselected for play-out next. The video may be selected for display in the windows MON1 and MON2 by dragging and dropping proxy video from windows W1 to W10 into MON 1 and MON 2. The video to be played out may be selected by clicking on MON1 or MON2.

5 The GUI of Figure 9 has an audio control display area AUD.

The GUI also has virtual controls C1 to C10 associated with the windows W 1 to W10 and controls CM associated with the MON1 and 2 windows. Operation of such a control causes the underlying software to send unicast control data UCD across the network directly to the source group from which the video in the associated window originates.

10 Alternatively, or in addition, C1 to C10 can indicate the current status of the relevant device.

The GUI of Figure 10 differs in minor ways from that of Figure 9. It has proxy video display areas W1 to W8, a network management area A1 (shown only schematically) identical to that of Figure 9, and monitor displays M1 and M2. The GUI of Figure 10 lacks the rows of source and destination buttons, but has two buttons M1 and M2 which act, like
15 the buttons of Figure 9, as switches. The buttons M1 and M2 select for play-out video associated with an associated one of windows M1 and M2. The played out video is displayed in a play-out window MP.

The windows M1 and M2 have associated audio controls A1 and A2 for switching on and off an audio monitor to allow the user to monitor the audio associated with the video of
20 windows M1 and M2.

The video to be displayed in windows M1 and M2 is dragged and dropped into those windows from the proxy video windows W1 to W8. That causes the full resolution video to be sent from the sources to full resolution monitors such as MON1 and MON2 in Figure 1 and to a video switcher such as D8 in Figure 1 via ENIC NI8. Operating the button M1 or
25 M2 causes the underlying software to send unicast control data UCD via the ENIC NI8 to the video switcher causing the video switcher to switch.

Figure 11 schematically illustrates a GUI that presents the operator with an overview of the network configuration. The GUI comprises a first source panel 110 that displays active sources and inactive sources belonging to the IP network. Source groups such as
30 cameras CAM1, CAM2, CAM 3 are represented. The video tape recorder group VTR1 has separate audio VTR A 1/2 VTR A 3/4 and video VTR V1 devices associated with it, which are also displayed. Both the source type e.g. MIC1 for a first microphone and the source name MIC A1/2 that specifies the audio channel device are represented in the first source panel 110. The source type is represented by an icon but the source name is not. An input

may be selected by highlighting a desired source on the first source panel 110, for example camera 1 CAM 1 is currently selected. A network review panel 112 comprises three sub-panels: a controllers sub-panel 114, a source sub-panel 116 and a destination sub-panel. The connection between a controller, a source and one or more destinations is represented by colour-coded branch connections between entries in the three sub-panels. The current configuration shows that a first controller CONT 1 is controlling the source group CAM1, which in turn is providing data to six different destination devices i.e. two monitors MON1, MON2, VTR1, an audio output AUDIO OUT 3, a digital signal processor DSP 2 and an output line LINE OUT 1. Figure 12 is one way of indicating the connections between sources and destinations across the network. Area 120 depicts groups (e.g. CAM1) and the associated source devices (e.g. V1, V2) and area 122 denotes destinations. Each source group has a coloured bar 124 associated with it. Area 121 is a matrix which uses the coloured bars to indicate the connections between sources and destinations. The source sub-panel 116 provides pull-down menus for each source that provide more detailed information about devices e.g. audio and video data streams associated with that source. The relationship between a source and digital signal processors (DSP) is indicated by colour coding in the left hand margin of the source sub-panel 116, for example in this case CAM 1 is associated with both DSP 2 and DSP 3. The names of the sources e.g. CAM 1, VTR 1, MIC 1 are derived from the tally text.

Figure 12 schematically illustrates a GUI that provides the user with an overview and an interface for displaying to an operator how the data is being routed across the network. The GUI comprises a routing review overview panel 121 at the top of the screen and a main routing review panel 122 comprising a source sub-panel 123 and a destination sub-panel 124. The overview routing review panel 121 provides an easily comprehensible overview of the relationships between sources and destinations. This is achieved by colour-coded highlighting. This panel 121 currently indicates that source CAM1 is connected to destinations MON1, MON2, MON3, VTR2 and AUOUT3. By clicking on a given source area of the routing review overview panel 121, that source and any destinations associated with it are highlighted. The sources sub-panel 124 provides an expanded view of the source in which both the source group e.g. CAM1 and the associated device V1 or V2 are graphically represented. Similarly, the destinations sub-panel provides an expanded view of the destination groups. From the highlighted areas in the sources sub-panel 121 and the destinations sub-panel 124 it is apparent that CAM1 device V1 is connected to devices V1

and V2 of MON1 for example. The destination sub panel 124 also provides a graphical colour coded matrix representation of source-destination connections.

Figure 13 schematically illustrates a user interface provided on the network manager via which a user may manually enter configuration data. When a device is connected to the network, the user informs the network manager that this is the case via the user interface. The interface comprises an ENIC ID dialog box, a PORT ID dialog box and a TALLY TEXT dialog box. The user enters into dialog boxes data required by the manager to determine the configuration of the network. The ENIC ID entry is a user-defined identifier e.g. ENIC6, the PORT ID entry specifies the ENIC port to which the device has been connected and the TALLY TEXT entry specifies the freely assignable label (referred to above as tally text) used as a source/destination identifier. The tally text ID is used in addition to (rather than as an alternative to) the source and destination identifiers ID discussed above.

15 References.

1, RTP Payload Format for BT.656 Video Encoding, D. Tynan, (Claddagh Films) RFC2431, Oct. 1998.

CLAIMS

1. A video network comprising:

5 a plurality of video sources to launch onto the network first, higher resolution, video data and second, lower resolution, video data providing a lower resolution representation of the higher resolution video data;

at least one destination device operable to process video received via network;

a network switch for selectively routing data from the video sources to the destination devices; and

10 a network control arrangement connected to the network switch and having:

- o a display device;
- o a graphical user interface (GUI) arranged to display, on the display device, the lower resolution representations of video data from the plurality of sources together with identifiers associating the lower resolution representations with the respective sources;
- 15 o means for user selection, by use of the GUI, of a source of video of the first resolution and a corresponding destination device; and
- o means for controlling the routing of the higher resolution video data from the selected video source to the selected destination device.

20 2. A network according to claim 1, in which the network control arrangement comprises a personal computer.

3. A network according to claim 1 or claim 2, in which the display device is arranged to display a plurality of display areas, each display area displaying the lower resolution
25 representation from a respective one of the video sources, together with the associated identifier.

4. A network according to any one of claims 1 to 3, in which the GUI provides one or more user-operable switches, identified by the identifiers, for selecting a destination device
30 to be connected to a selected video source.

5. A network according to claim 4, in which:

the network control arrangement comprises a user input device for selecting display screen areas; and

the user operable switches are display screen areas selectable by the user input device.

6. A network according to claim 4, in which:

5 the display screen is a touch-sensitive display screen; and
the user operable switches are display screen areas selectable by the user touching those display screen areas.

7. A network according to claim 4, in which the network control arrangement
10 comprises a plurality of user-operable buttons, the buttons corresponding to video sources and/or destination devices for selection.

8. A network according to claim 4, in which the GUI provides at least one selection
15 display area and is arranged so that a source is selected for connection to a destination by dragging and dropping a displayed representation corresponding to that video source into the selection display area.

9. A network according to any one of the preceding claims, the network being a
20 packet-based network in which the video sources are associated with different respective multicast groups.

10. A network according to claim 9, in which each source is associated with at least two
25 respective multicast groups, one multicast group being associated with the higher resolution video from that source and another multicast group being associated with the lower resolution video from that source.

11. A network according to claim 9 or claim 10, in which the network control
30 arrangement controls routing from a selected video source to a selected destination device by sending a message to the destination device to cause the destination device to join the multicast group of the selected source.

12. A network according to any one of the preceding claims, comprising a plurality of destination devices.

13. A network according to any one of the preceding claims, in which at least one destination device comprises a video switching device.

5 14. A network according to any one of the preceding claims, in which at least one destination device comprises a video display device.

15. A network according to any one of the preceding claims, in which at least one video source comprises a video tape recorder.

10

16. A network according to any one of the preceding claims, in which at least one video source comprises a video camera.

17. A network according to any one of the preceding claims, in which:

15 at least one of the video sources and/or destination devices is arranged to launch status packets providing device status information onto the network; and

the GUI is arranged to display such status information in association with a representation of that device.

20 18. A network according to any one of the preceding claims, in which:

the GUI provides user controls to control the operation of at least one of the video sources and/or destination devices; and

the network control arrangement is operable to transmit control packets providing control information to such a device.

25

19. A video network control arrangement for use in a video network having a plurality of video sources to launch onto the network first, higher resolution, video data and second, lower resolution, video data providing a lower resolution representation of the higher resolution video data; at least one destination device operable to process video received via network; and a network switch, connectable to the network controller, for selectively routing data from the video sources to the destination devices;

30

the network control arrangement comprising:

- o a graphical user interface (GUI) arranged to display, on a display device, the lower resolution representations of video data from the plurality of sources together with identifiers associating the lower resolution representations with the respective sources;
- o means for user selection, by use of the GUI, of a source of video of the first resolution and a corresponding destination device; and
- o means for controlling the routing of the higher resolution video data from the selected video source to the selected destination device.

20. A network control arrangement according to claim 19, comprising a display device.

21. A video network substantially as hereinbefore described with reference to the accompanying drawings.

22. A network controller substantially as hereinbefore described with reference to the accompanying drawings.

23. A method of operation of a video network controller in a video network having a plurality of video sources to launch onto the network first, higher resolution, video data and second, lower resolution, video data providing a lower resolution representation of the higher resolution video data; at least one destination device operable to process video received via network; and a network switch, connectable to the network controller, for selectively routing data from the video sources to the destination devices;

the method comprising:

- o displaying, on a display device, the lower resolution representations of video data from the plurality of sources together with identifiers associating the lower resolution representations with the respective sources;
- o providing user selection of a source of video of the first resolution and a corresponding destination device; and
- o controlling the routing of the higher resolution video data from the selected video source to the selected destination device.

24. A method of operation of a network controller, the method being substantially as hereinbefore described with reference to the accompanying drawings.

25. Computer software having program code for carrying out a method according to claim 23 or claim 24.

5 26. A medium by which software according to claim 25 is provided.

27. A medium according to claim 26, the medium being a storage medium.

28. A medium according to claim 26, the medium being a transmission medium.

ABSTRACTVIDEO NETWORK

A video network comprises a plurality of video sources to launch onto the network first, higher resolution, video data and second, lower resolution, video data providing a lower resolution representation of the higher resolution video data; at least one destination device operable to process video received via network; a network switch for selectively routing data from the video sources to the destination devices; and a network control arrangement connected to the network switch and having:

- a display device;
- 10 ◦ a graphical user interface (GUI) arranged to display, on the display device, the lower resolution representations of video data from the plurality of sources together with identifiers associating the lower resolution representations with the respective sources;
- means for user selection, by use of the GUI, of a source of video of the first resolution and a corresponding destination device; and
- 15 ◦ means for controlling the routing of the higher resolution video data from the selected video source to the selected destination device.

(Fig. 11)

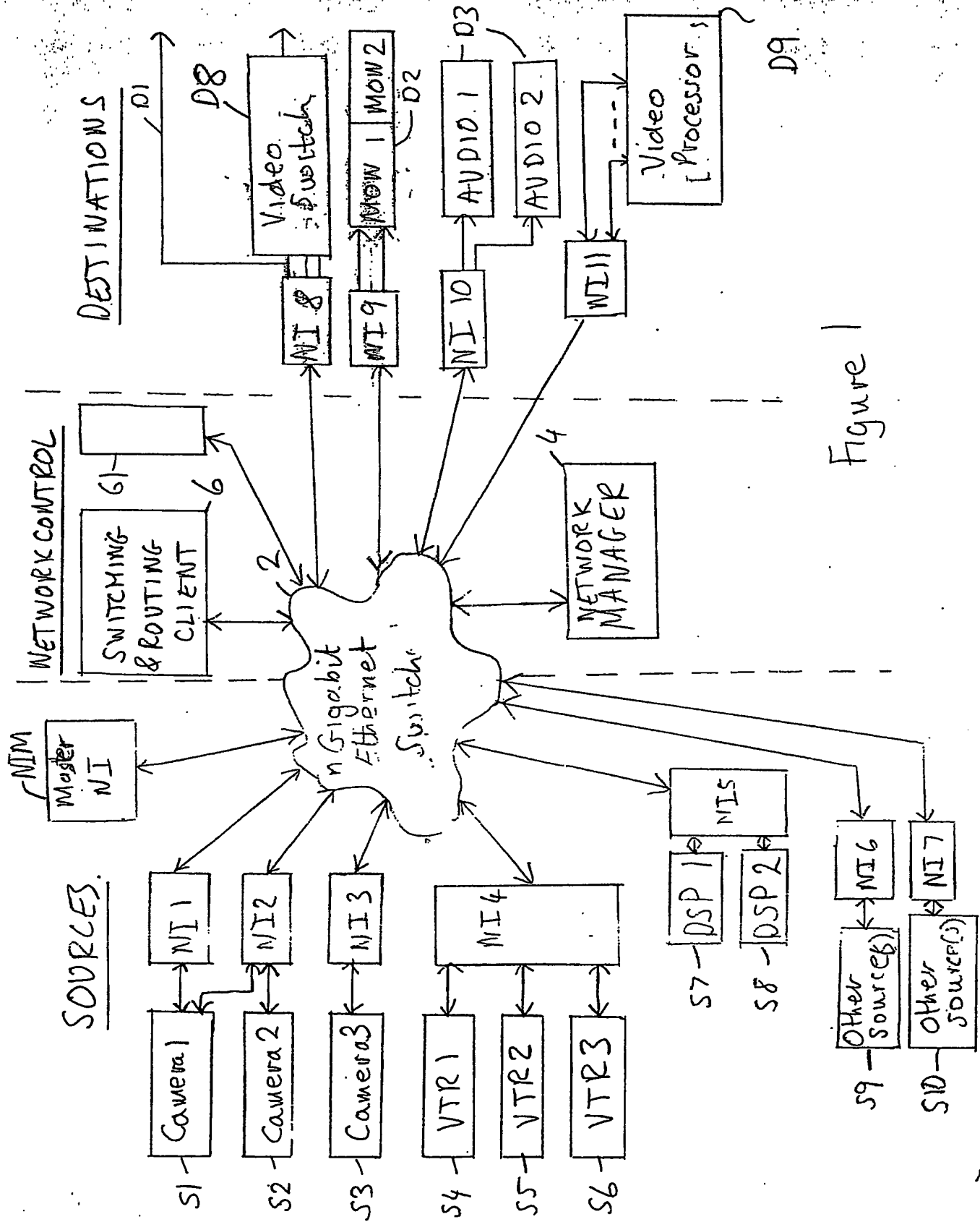
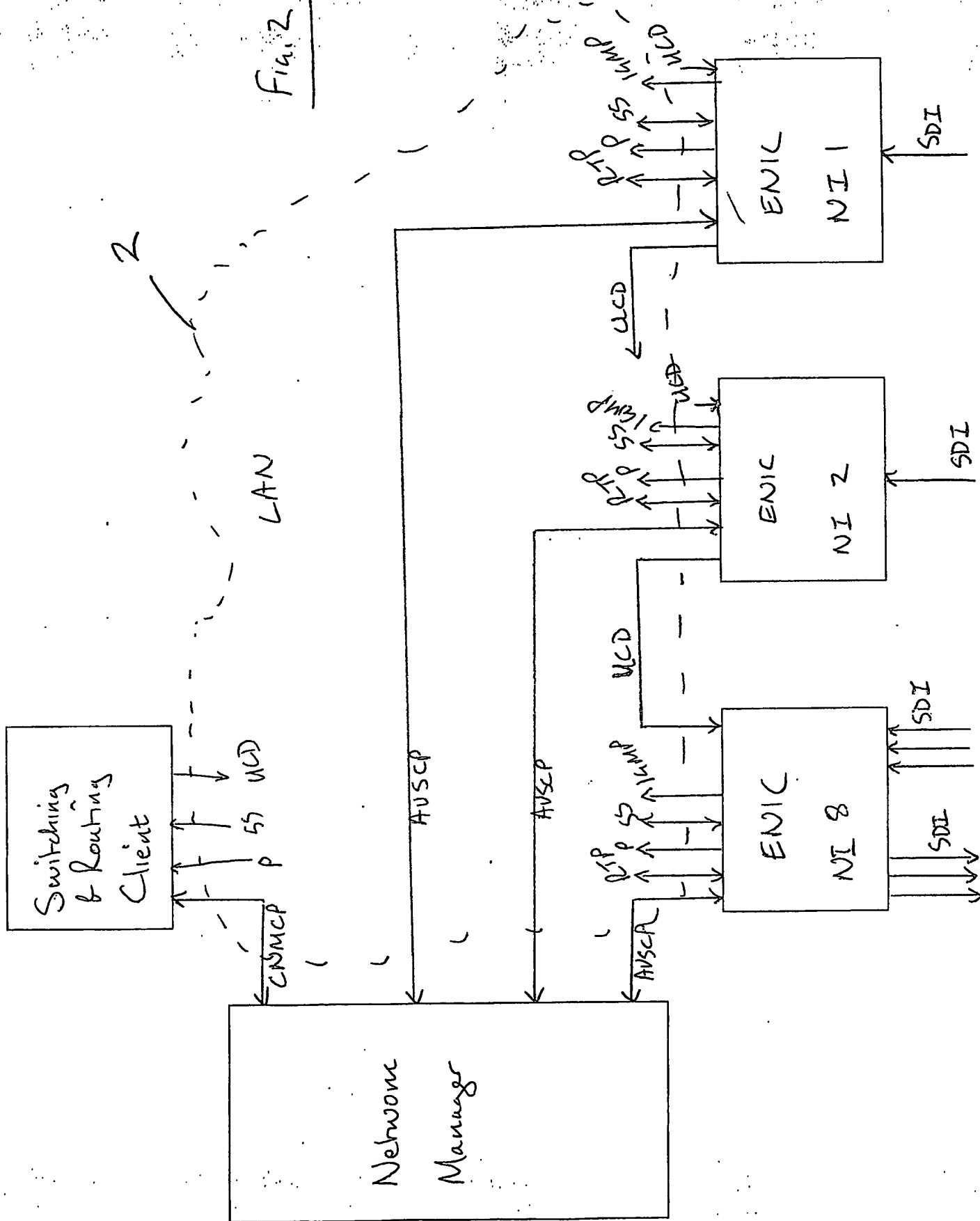


Figure 1

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Fig. 2



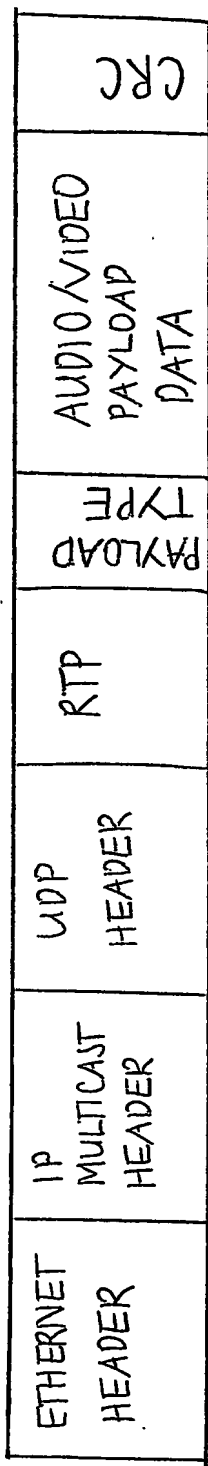


FIG 3A AUDIO/VIDEO

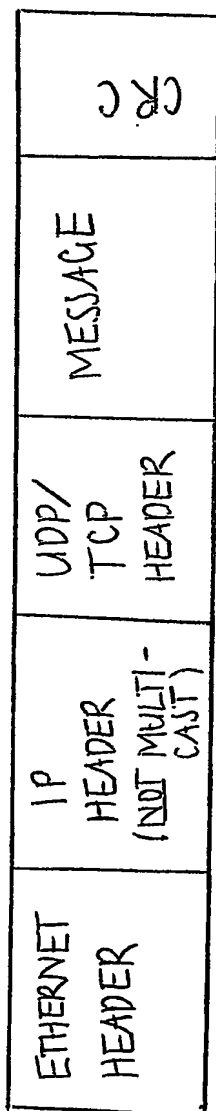


FIG 3B AVSCP/CNMCP

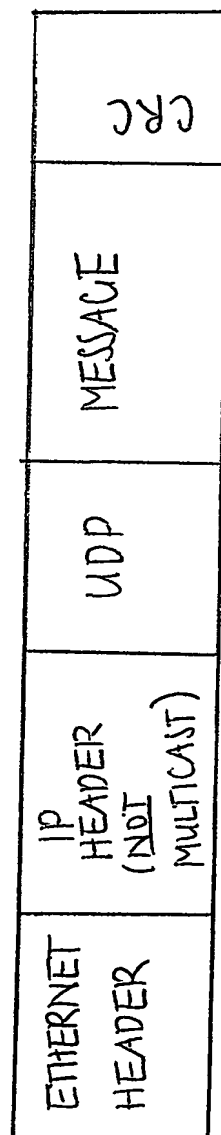
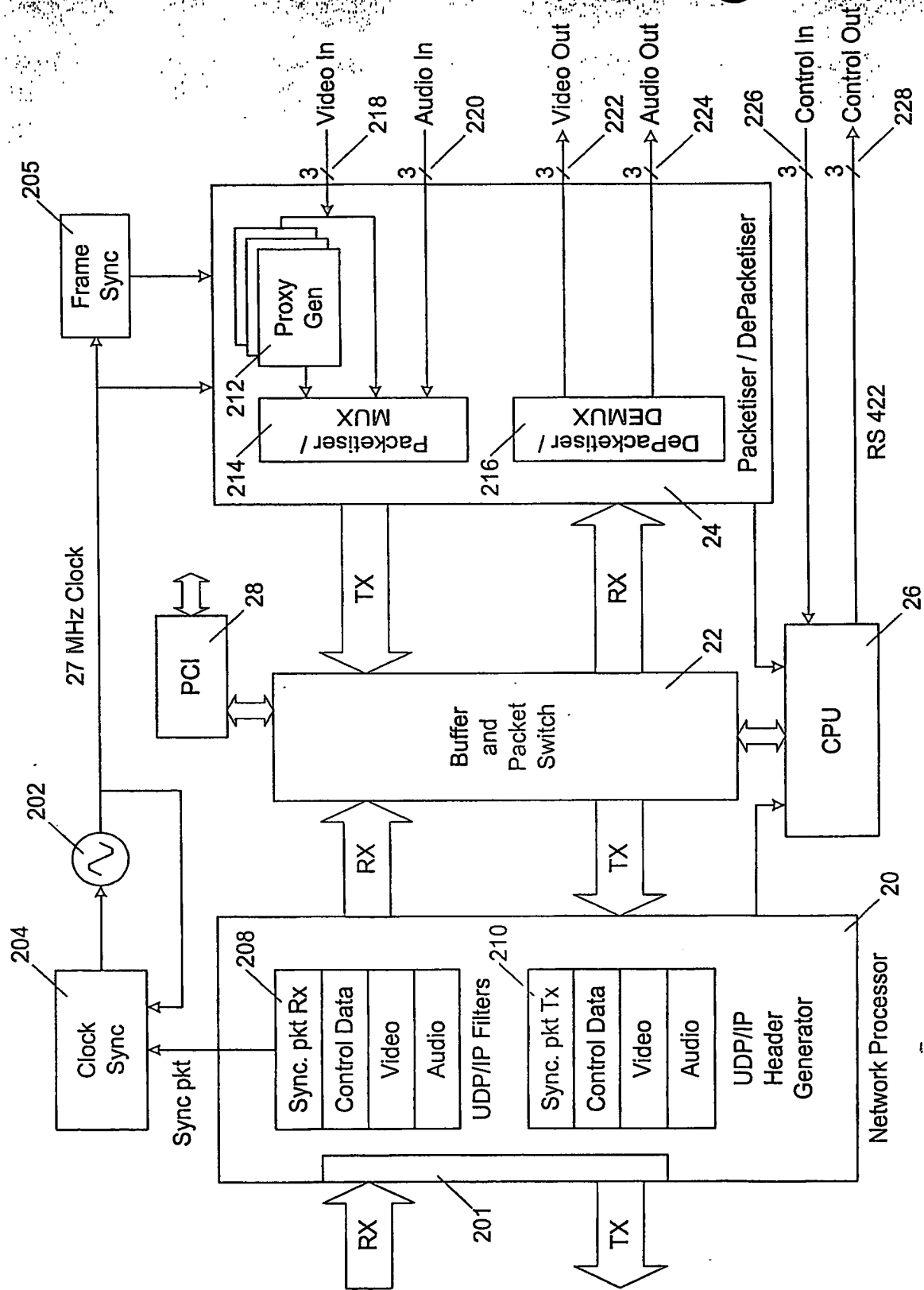


FIG 3C



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Flow 0 (Evaporate)
Flow 1 (Net-Video IO)
Flow 2 (Net-CPU)
Flow 3 (Net-PCI)
Flow 4 (Video IO-Net)
Flow 5 (CPU-Net)
Flow 6 (PCI-Net)

Example of the current flow assignment

FIG 5B

Flow (8)	Type (8)	Size (16)
0x0		
Payload		

Example of a packet with a tag

FIG 5A

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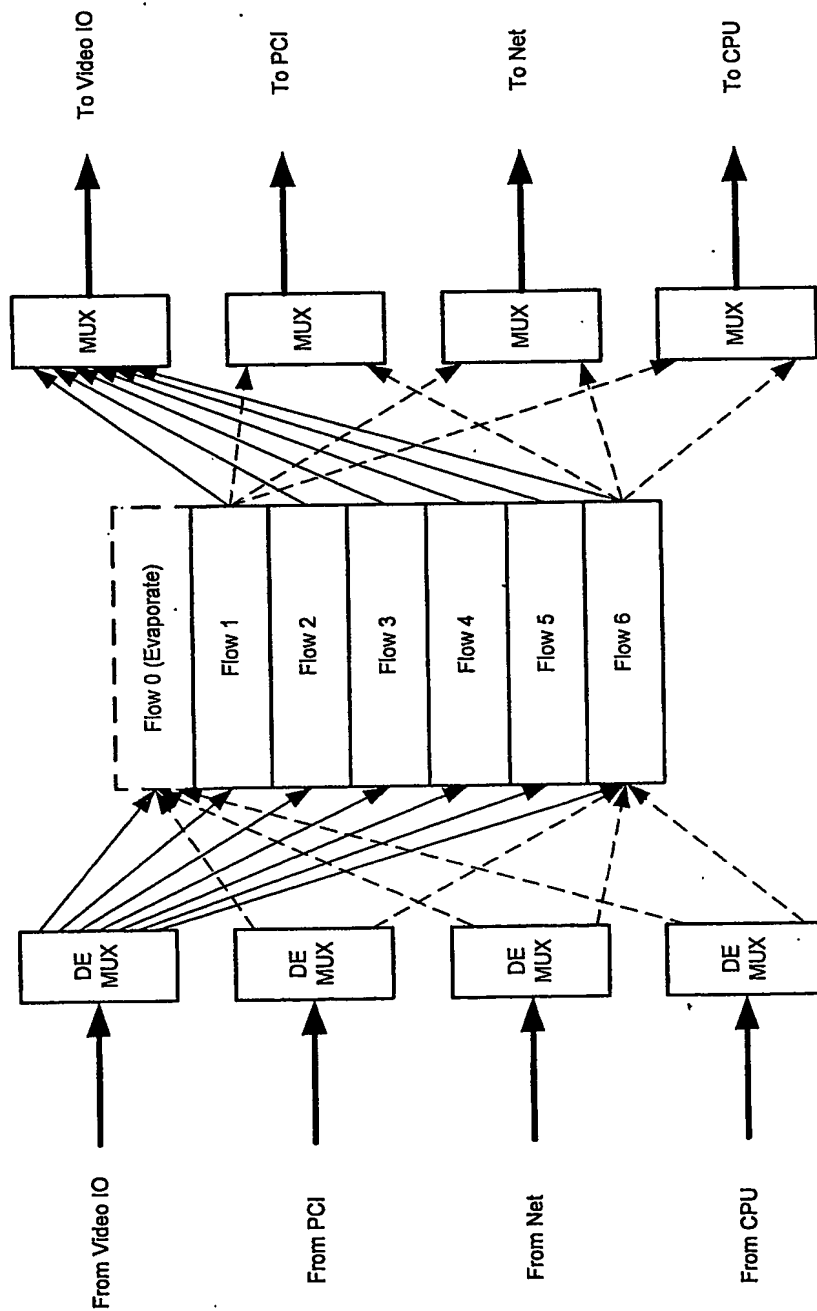
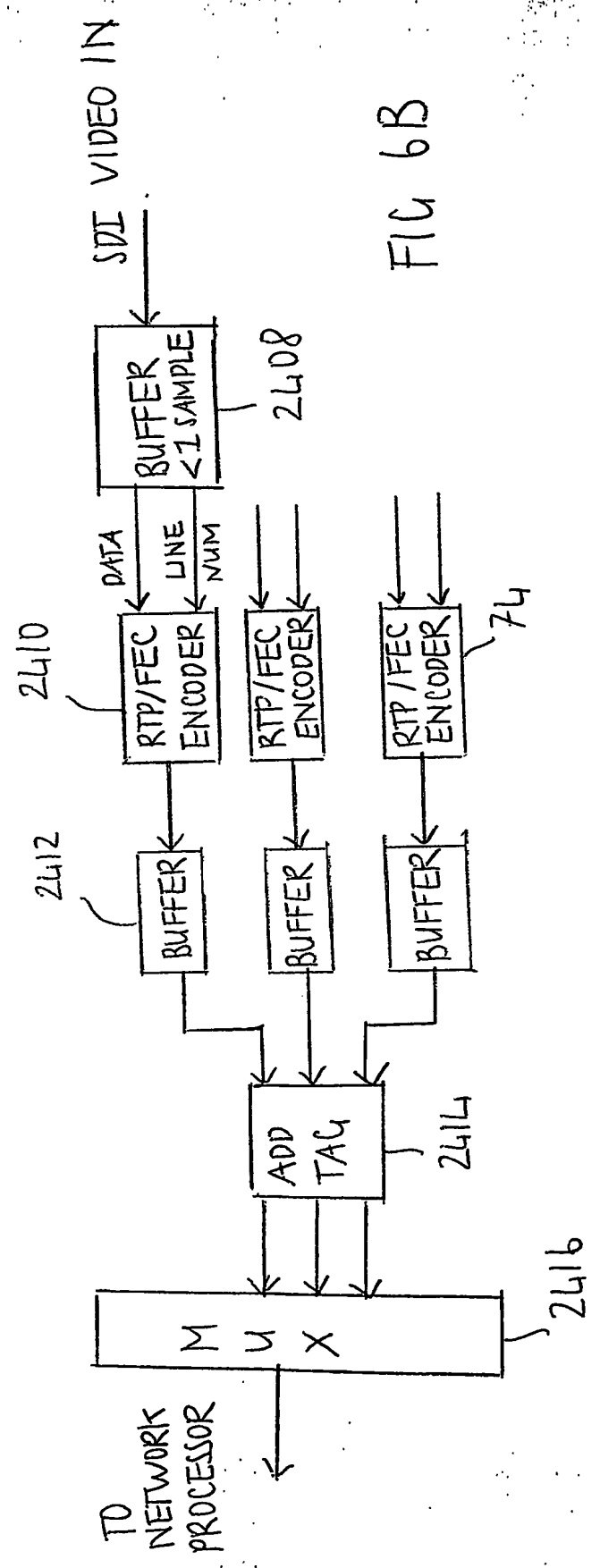
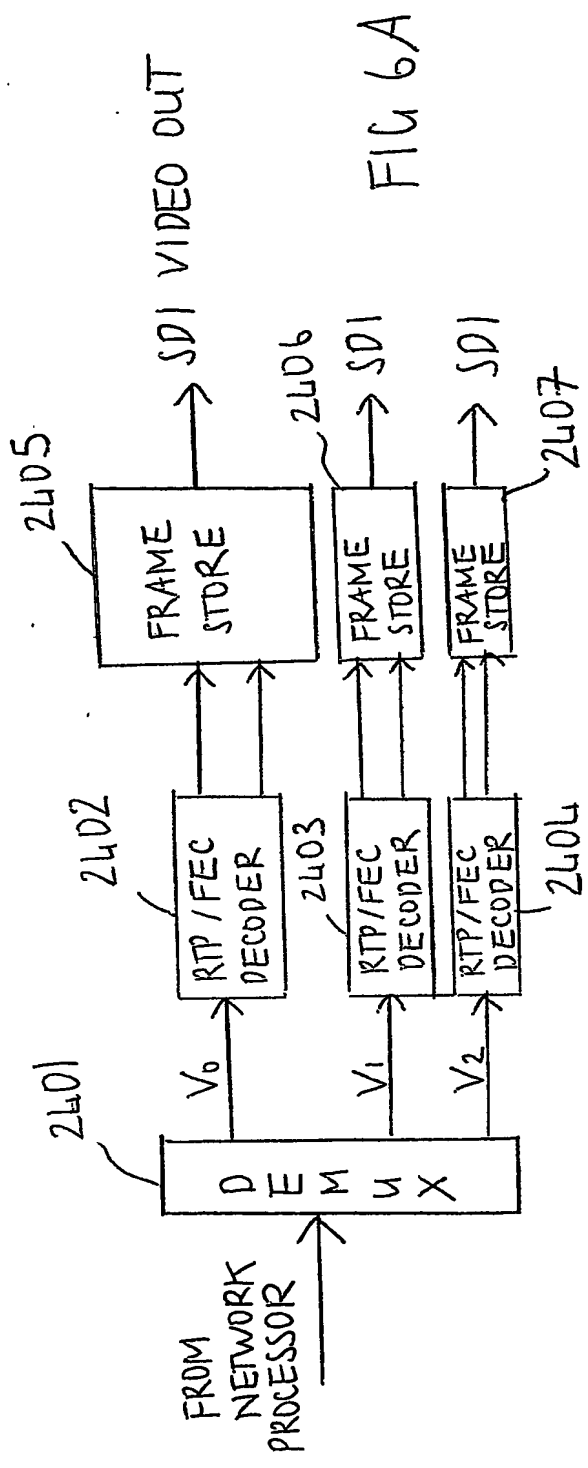


FIG 5C



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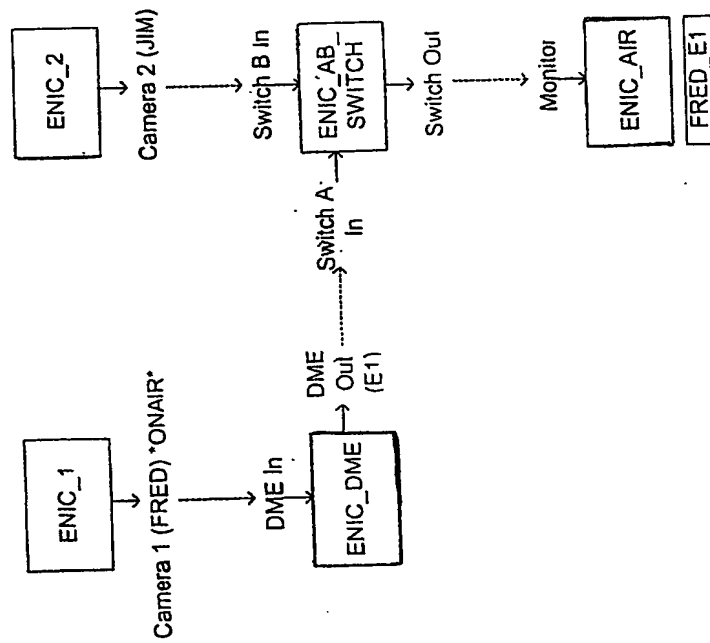


Figure 7

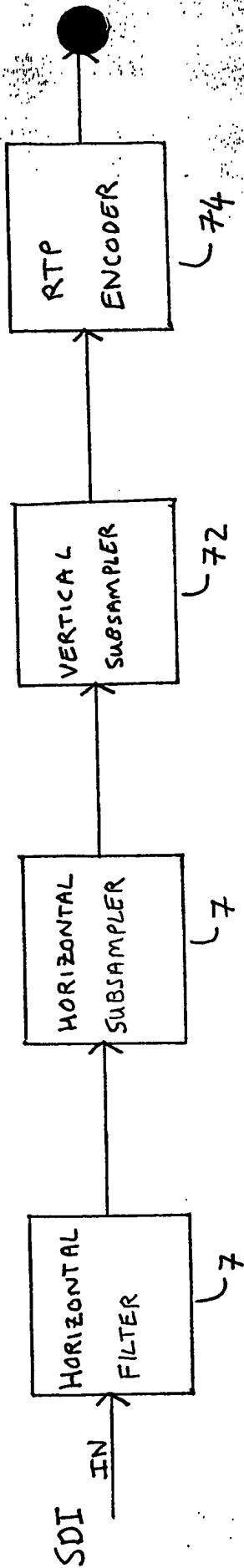


Figure 8

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W L7

L5

W5

C5

L10

W10

C10

M2

Network review

Source content review

Other

Source	CAM 1	00:00:00:00	CAM 2	00:00:00:00	CAM 3	00:00:00:00	DSP1	00:00:00:00	LINE1	00:00:00:00
CAM 1	Source name1		Source name1							
CAM 2	Source name2		Source name2							
CAM 3	Source name3		Source name3							
CAM 4	Source name4		Source name4							
CAM 5	Source name5		Source name5							
CAM 6	Source name6		Source name6							
CAM 7	Source name7		Source name7							
CAM 8	Source name8		Source name8							
CAM 9	Source name9		Source name9							

VTR1 00:00:00:00 VTR 2 00:00:00:00 VTR 3 00:00:00:00

VTR A1/2 VTR A3/4 VTR V1 VTR 2 VTR 3

MIC1 MIC 2 MIC 3

DSP1 DSP - CG DSP2 DSP3

LINE IN 1 LINE IN 2 LINE IN 3

Routing review

Source	CAM 1	CAM 2	CAM 3	VTR 1	VTR 2	VTR 3	MIC 1	MIC 2	MIC 3	DSP 1	DSP 2	DSP 3	LINE IN 1	LINE IN 2	LINE IN 3
DEST	MON 1	MON 2	MON 3	VTR 1	VTR 2	VTR 3	MON 1	MON 2	MON 3	DSP 1	DSP 2	DSP 3	LINE OUT 1	LINE OUT 2	LINE OUT 3

AVD CMI M1

FIG. 9

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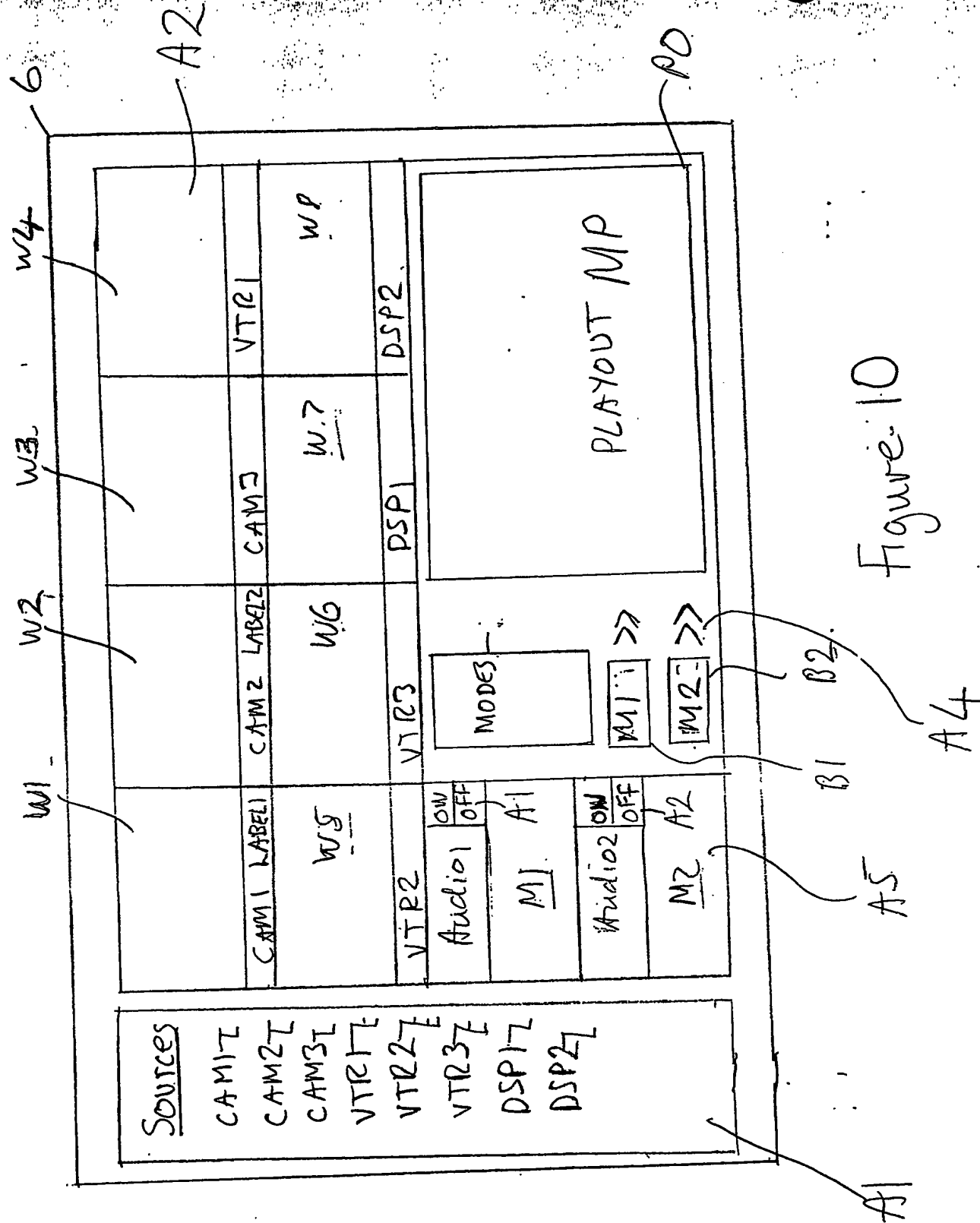
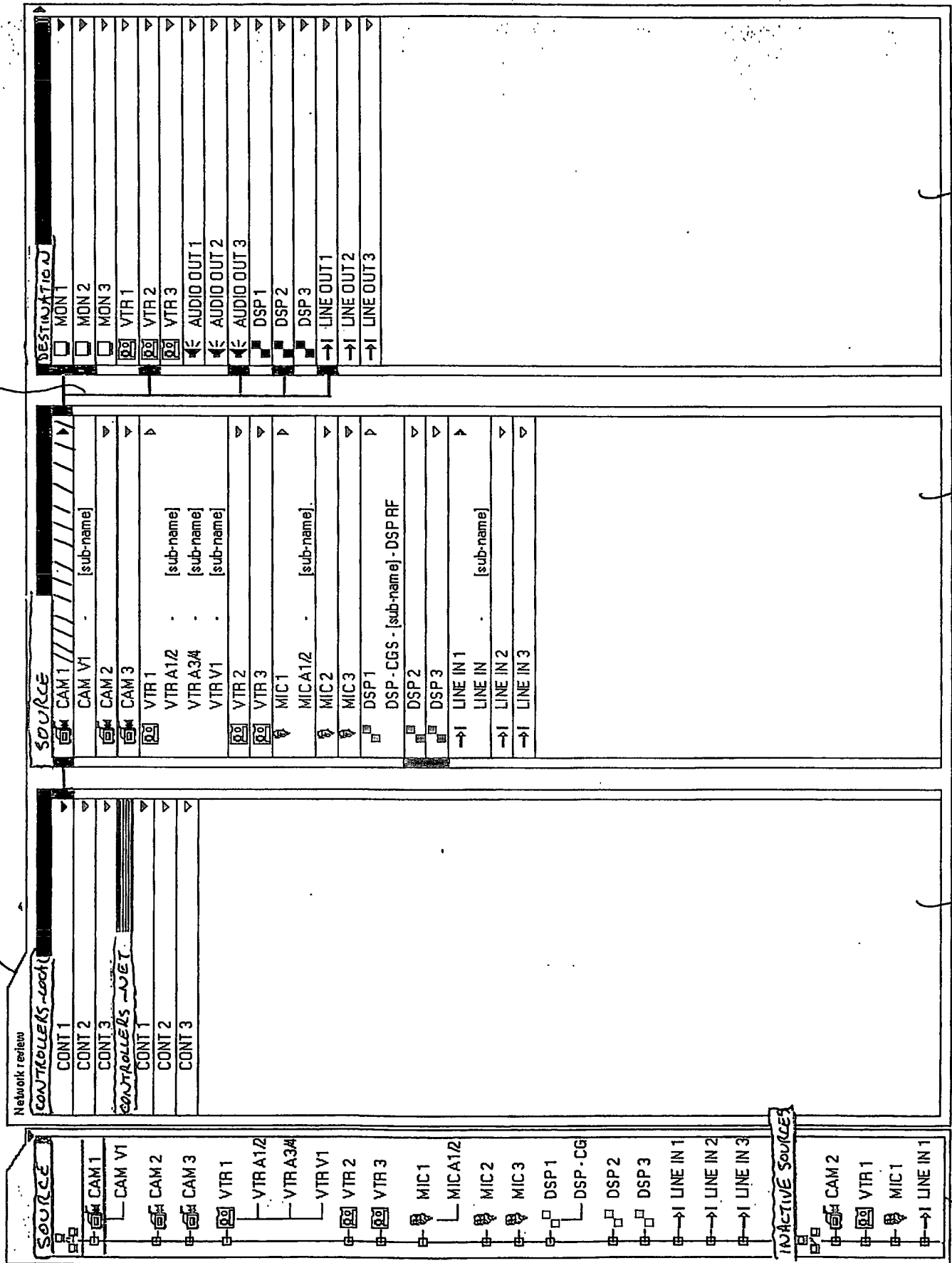


Figure 10

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source/destⁿ relation



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~121

~123

~124

Routing review

SOURCE	CAM1	CAM2	CAM3	VTR1	VTR2	VTR3	MIC1	MIC2	MIC3	LINE IN1
DESTIN	MON1	MON2	MON3	VTR1	VTR2	VTR3	VTR4	VTR5	AUD OUT3	LINE OUT1

122

SOURCES	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
CAM1	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
CAM2	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
CAM3	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
VTR1	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
VTR2	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
VTR3	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
MIC1	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
MIC2	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
MIC3	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
DSP1	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
DSP2	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
DSP3	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
LINE IN1	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
LINE IN2	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
LINE IN3	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
LINE OUT1	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
LINE OUT2	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
LINE OUT3	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V

DESTINATIONS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
MON1	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
MON2	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
MON3	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
VTR1	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
VTR2	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
VTR3	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
AUDIO OUT1	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
AUDIO OUT2	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
AUDIO OUT3	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
DSP1	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
DSP2	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
DSP3	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
LINE OUT1	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
LINE OUT2	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
LINE OUT3	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V

DESTINATIONS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
MON1	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
MON2	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
MON3	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
VTR1	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
VTR2	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
VTR3	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
AUDIO OUT1	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
AUDIO OUT2	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
AUDIO OUT3	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
DSP1	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
DSP2	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
DSP3	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
LINE OUT1	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
LINE OUT2	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
LINE OUT3	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V

FIG 12

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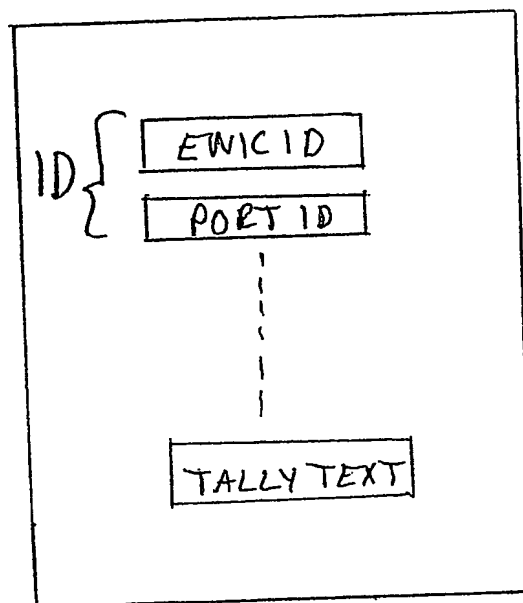


Figure 13

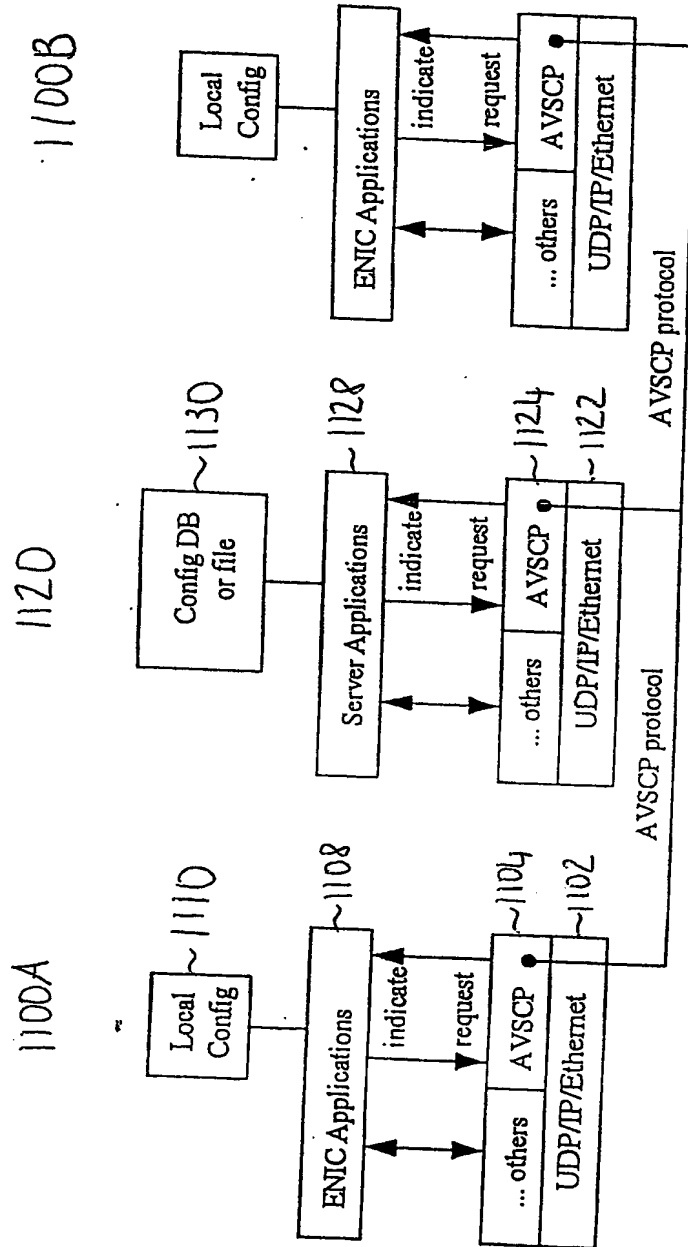


FIG 14

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0	78	1516	2324	31
Protocol-ID		Version	Reserved	Message-Type
Session-ID				

FIG 15

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